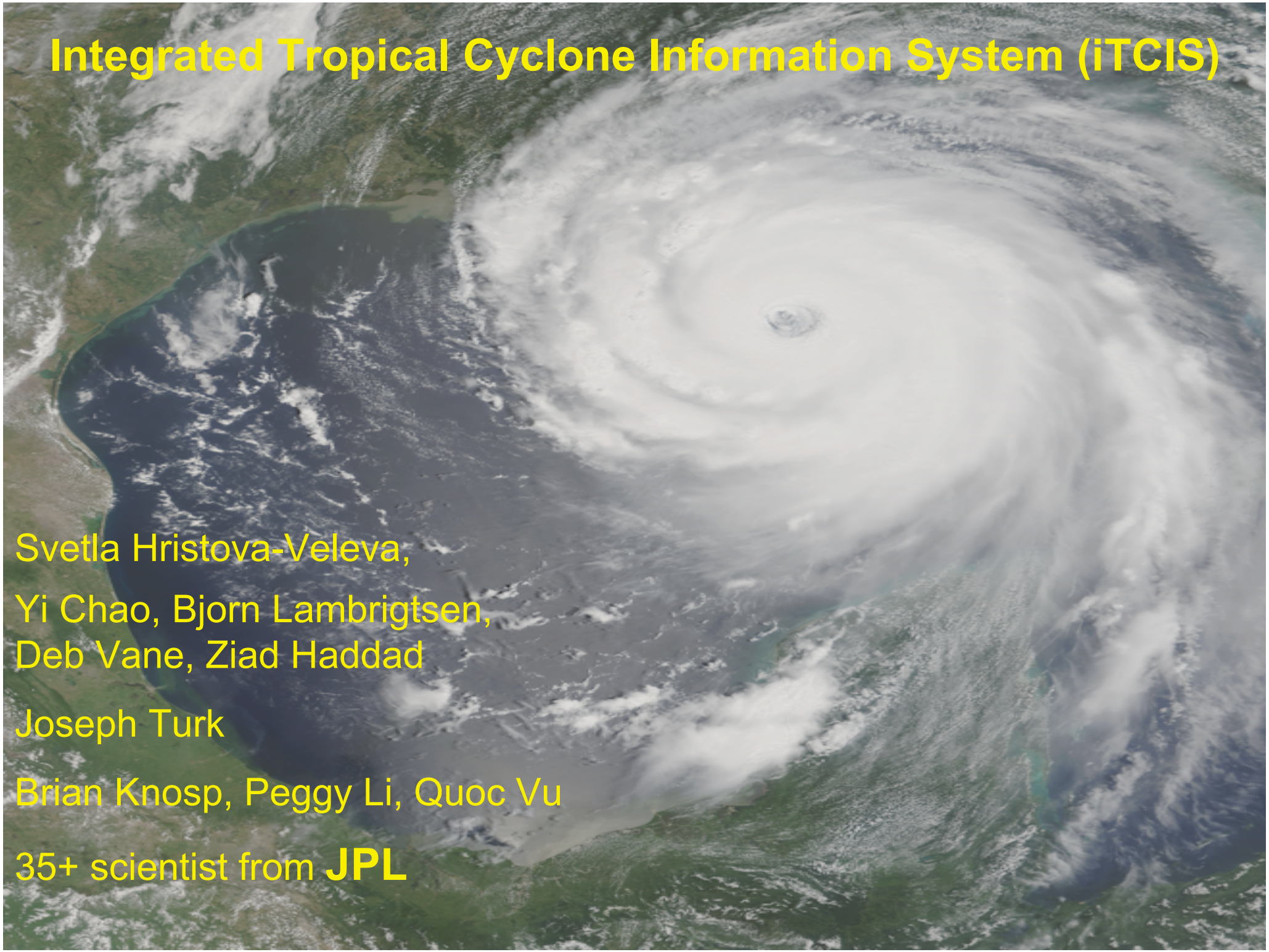
Integrated Tropical Cyclone Information System (iTCIS)



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Deb Vane, Ziad Haddad

Joseph Turk

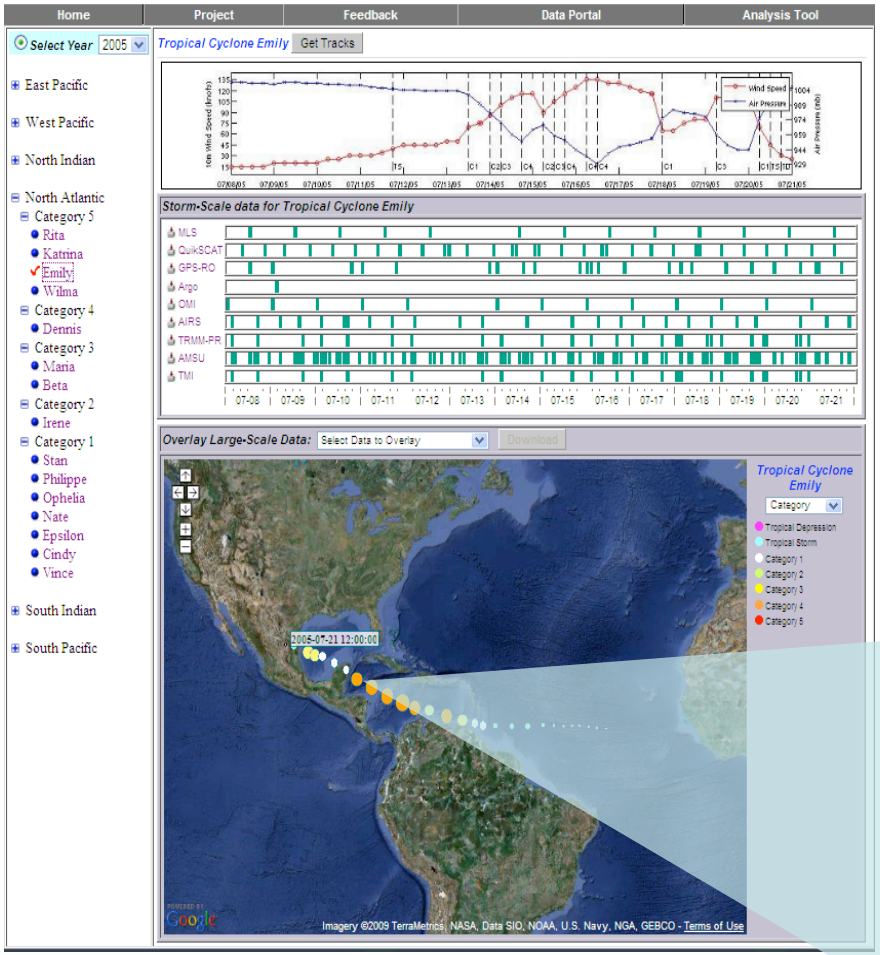
Brian Knosp, Peggy Li, Quoc Vu

35+ scientist from **JPL**

Tropical Cyclone – Integrated Data Exchange and Analysis System (**TC-IDEAS**) - **coming soon as Part of the HSRP**

Joint NASA Jet Propulsion Lab and Marshall Space Flight Center Project

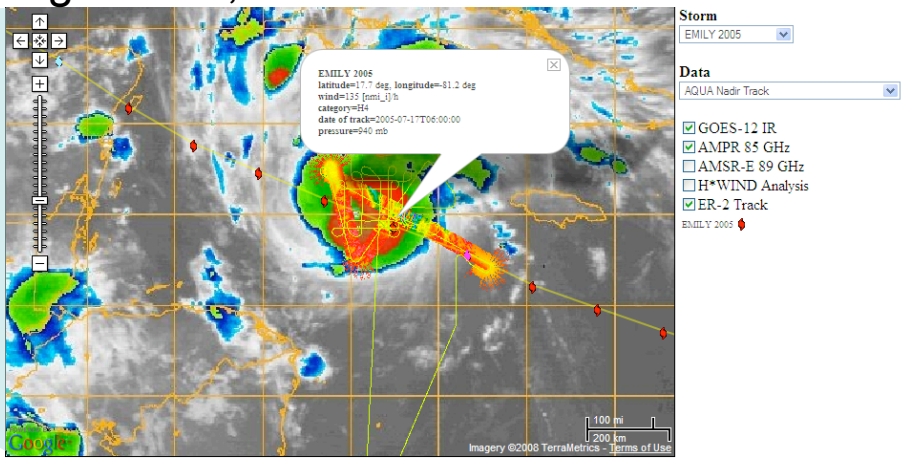
The JPL iTCIS



Select by basin, name, or category with corresponding data availability timelines

Objective: To provide fusion of multi-parameter hurricane observations (satellite, airborne and *in-situ*) and model simulations with the purpose of:

- supporting both research and field campaigns
- understanding the physical processes
- improving hurricane forecast by facilitating model validation and data assimilation
- enabling the development of new algorithms, sensors and missions.



ER-2 /AMPR data overlaid on GOES IR

Motivation for developing iTCIS and the coming soon TC-IDEAS

- In spite of recent improvements in hurricane track forecast accuracy, there are still many unanswered questions about the physical processes that determine hurricane genesis, track and intensity.
- Furthermore, there is a pressing need to validate and improve hurricane forecast models!!
- None of this can be accomplished without bringing together models and observations into a common analysis system which does not yet exist
- The JPL-MSFC team is very well positioned to accomplish that because of our:
  - extensive experience with satellite and airborne observations and intimate knowledge about retrieved products
  - ability to bring observations and models together by developing instrument simulators that use the model output and generate satellite "observables" needed:
    - for model-data comparisons
    - for data assimilation
    - for instrument and mission design

The components of TC-IDEAS

- **Observations**
  - Satellite, airborne, in-situ
  - Large scale and storm scale
  - All storm scale observations are presented in a common space, centered on the storm
  - Data and images
  - Data are organized in an easy way to determine when coincident observations are present
- **Google Earth applications for Real Time Mission Monitoring (RTMM) and on-demand overlay of various observations**
- **High-resolution model simulations**
- **Instrument simulators** (e.g. radar reflectivity, brightness temperatures etc. at the geometry of current and future missions)
- **Analysis tools**
  - Principal Component Analysis; CFADs (Contoured Frequency by Altitude Diagrams)
  - Multiparameter, spatial and temporal covariances for use in data assimilation
  - Data query tools

2 main components
In the current
JPL iTCIS

Jet Propulsion Laboratory
California Institute of Technology

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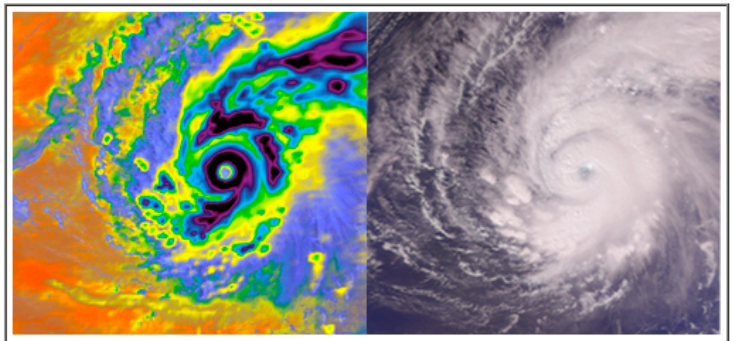
JPL Tropical Cyclone Information System

Home | Project | Feedback | Data Portal | Analysis Tool

Welcome to the JPL Tropical Cyclone Information System

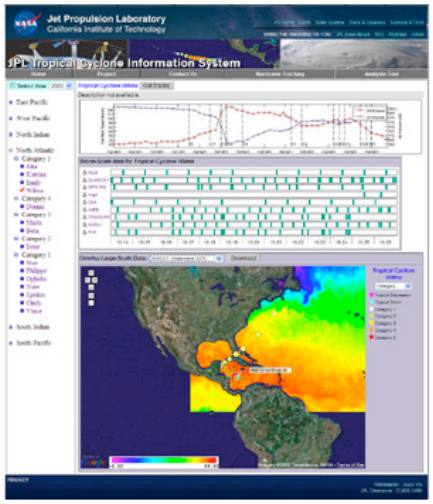
The JPL Tropical Cyclone Information System (TCIS) brings together satellite and in situ data sets from various sources to help you find information for a particular tropical cyclone over the world ocean. Currently, we have populated the entire 2005 and we will add data from other years in the future. We hope that you will find our analysis tools useful for your studies to improve hurricane models and plan future satellite missions with a particular focus on tropical cyclones.



Supertyphoon Pongsona struck the U.S. Island of Guam on Sunday, December 8, 2002. The composite image (left) of the supertyphoon was made by overlaying data from the infrared, microwave, and visible/near-infrared sensors that make up the AIRS sounding system. This storm can also be seen with the standard AIRS Vis/NIR (right).

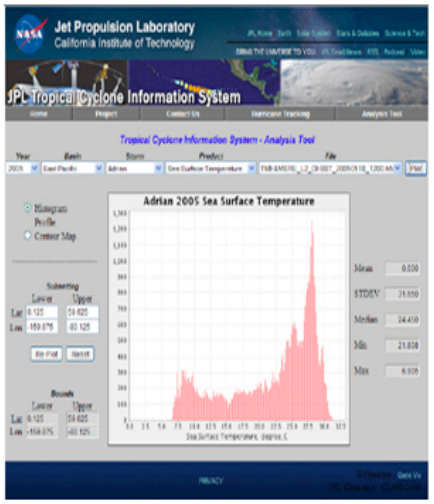
Tropical Cyclone Data Portal

Here you can search for specific storms in 2005 and directly access data and plots associated with that storm.



Data Analysis Tool

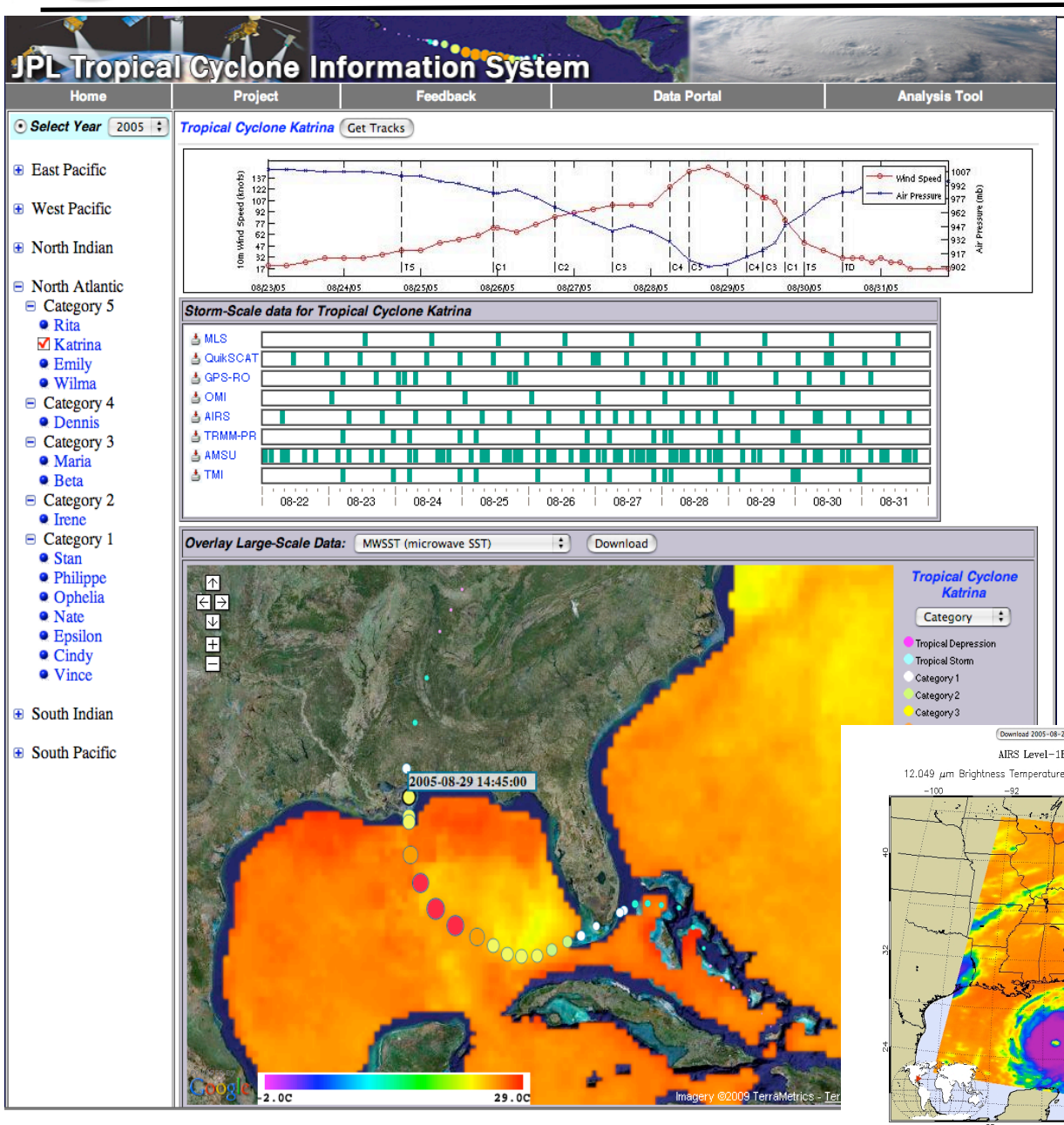
This tool will let you analyze data associated with a storm. You can plot histograms, maps, and profiles for many different data sets and products.

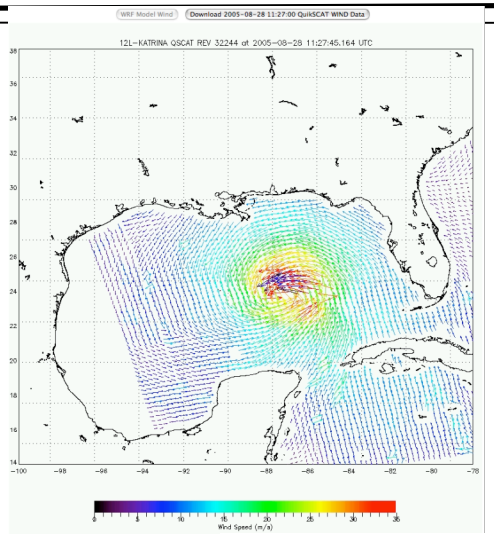


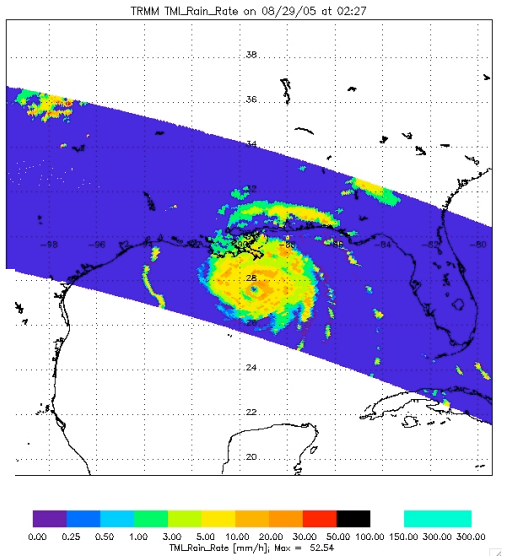
PRIVACY

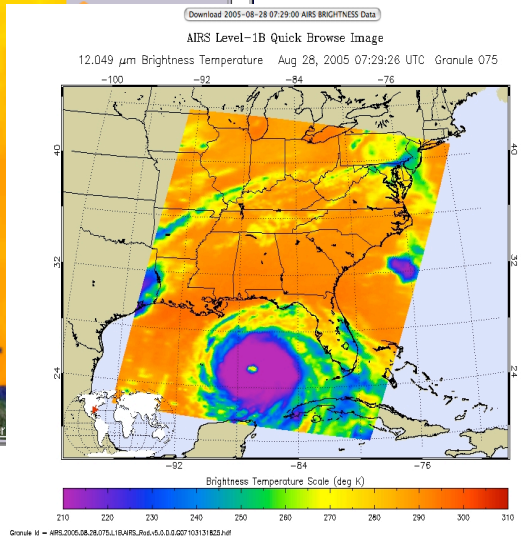
Webmaster: Quoc Vu
JPL Clearance: CL#08-3490

TOPICAL CYCLONE DATA PORTAL – CURRENT STATUS



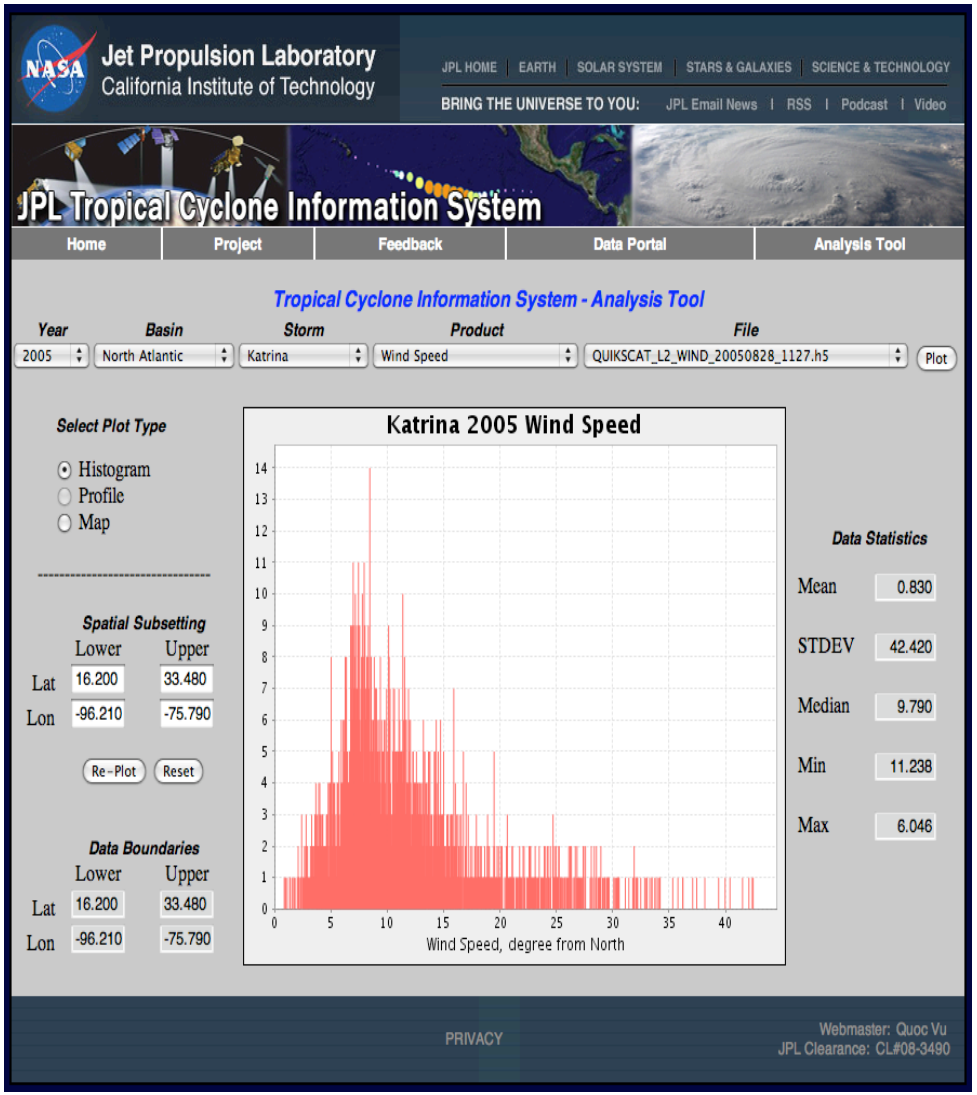


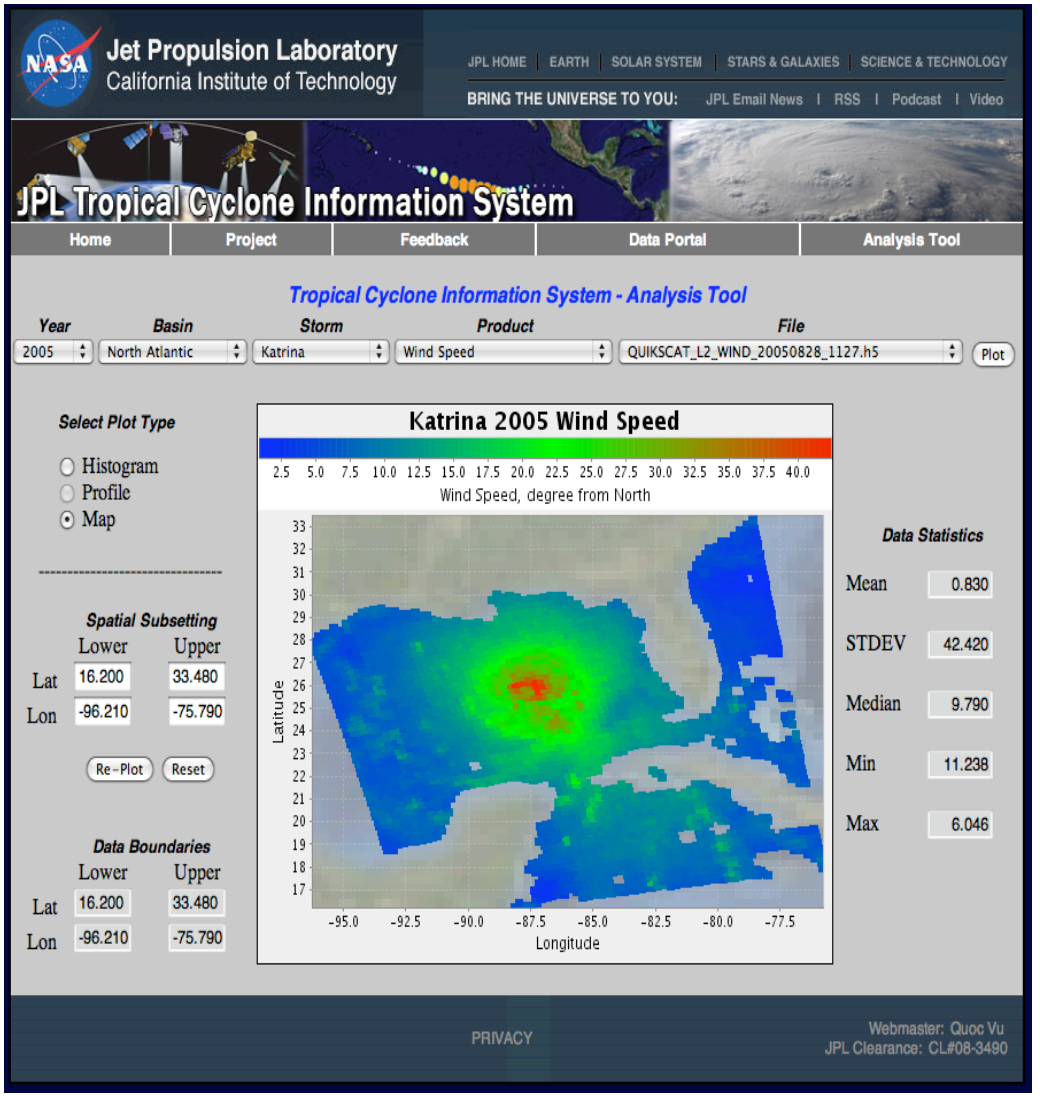




Analysis Tools – CURRENT STATUS

Single Parameter Statistics





High-resolution modelling - to be included soon

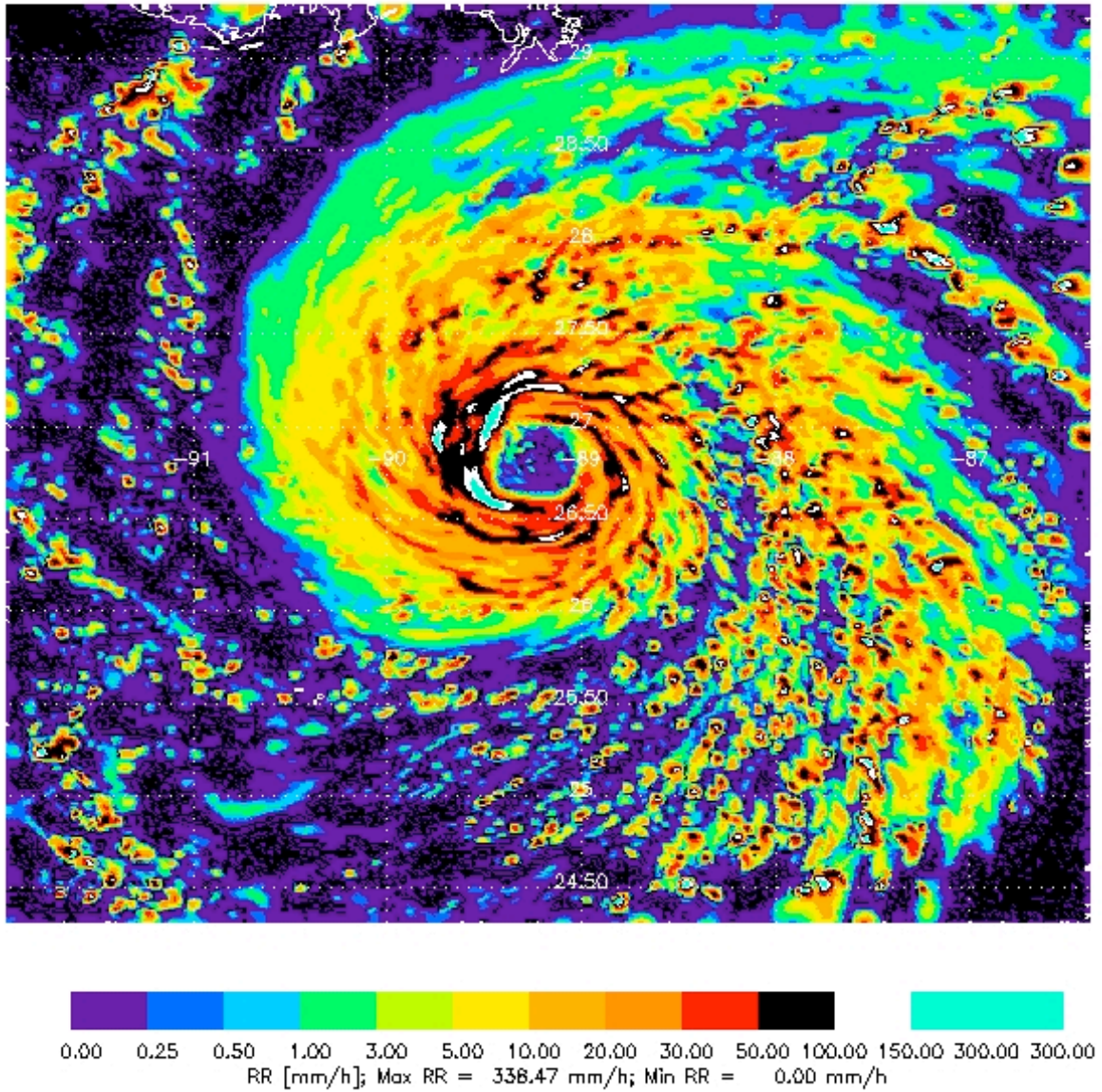
WRF Model Simulations - RITA, September, 2005

High-resolution model simulations provide a very detailed information on the structure and evolution of hurricanes. Observations with such high-resolution in both space and time do not yet exist!

We could learn a lot about hurricane processes by studying model simulations.

However, this is true ONLY if we trust the model simulations ...

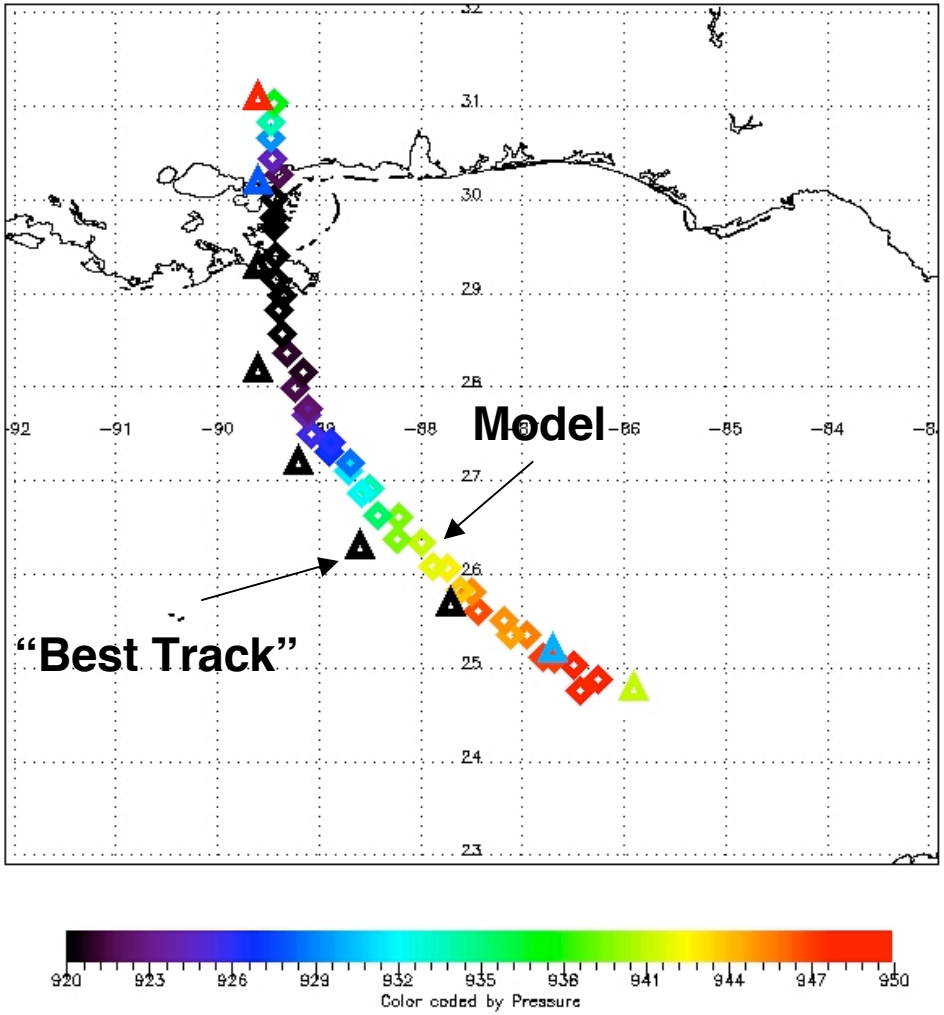
Detailed model - data comparisons are needed to validate and improve the models.



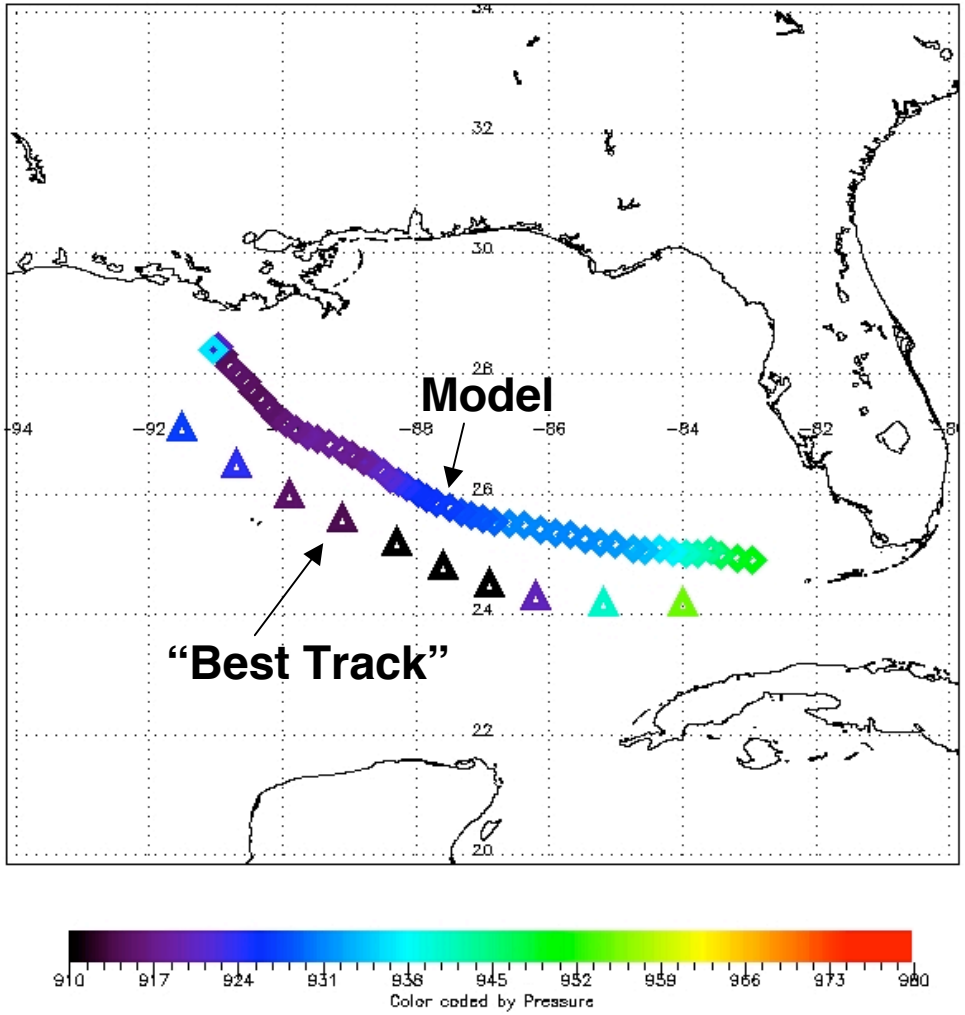
Evaluating hurricane simulations….

Tracks of simulated and observed storms

KATRINA - 2005



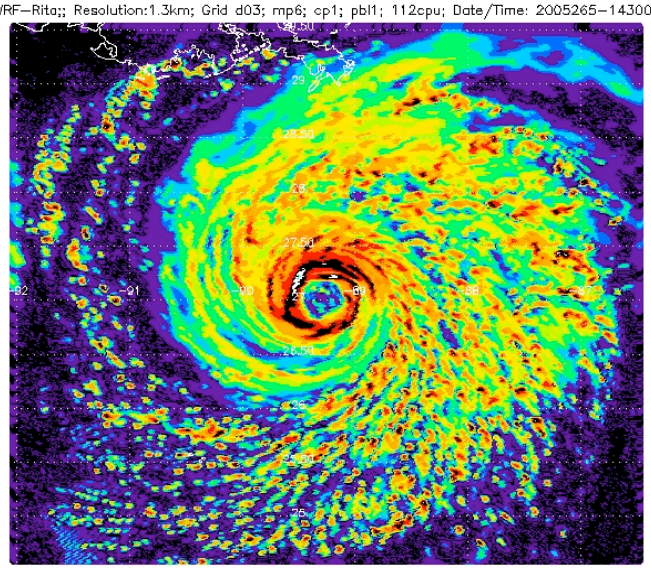
RITA - 2005



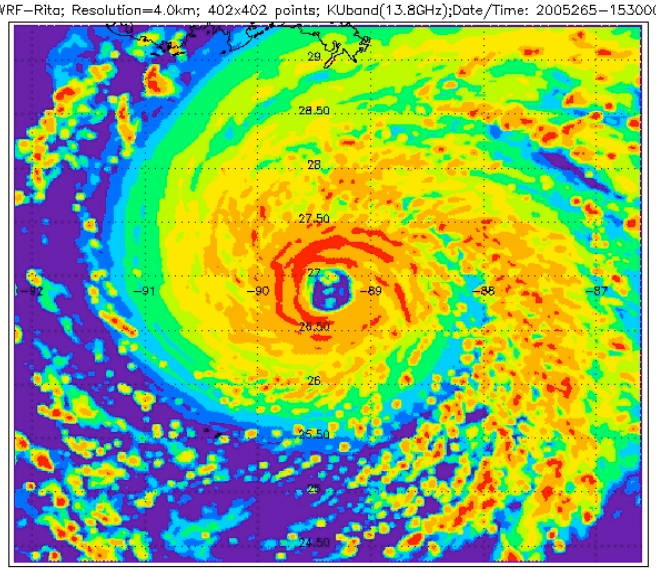
Instrument Simulators for model evaluation

JPL

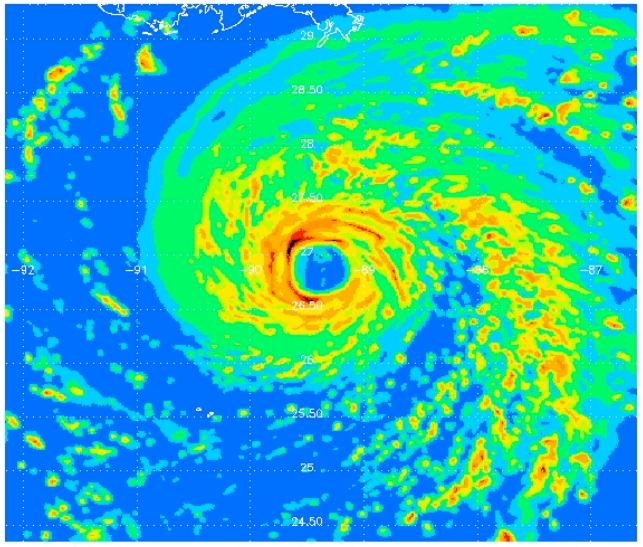
WRF - Rain Rate



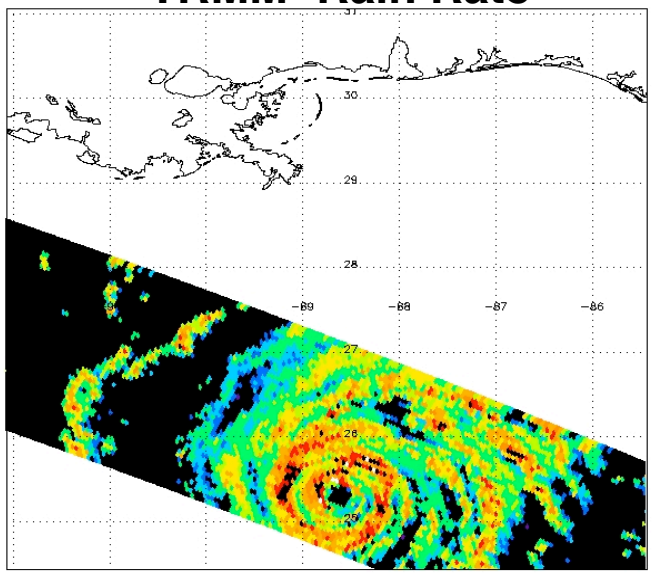
WRF - max reflectivity



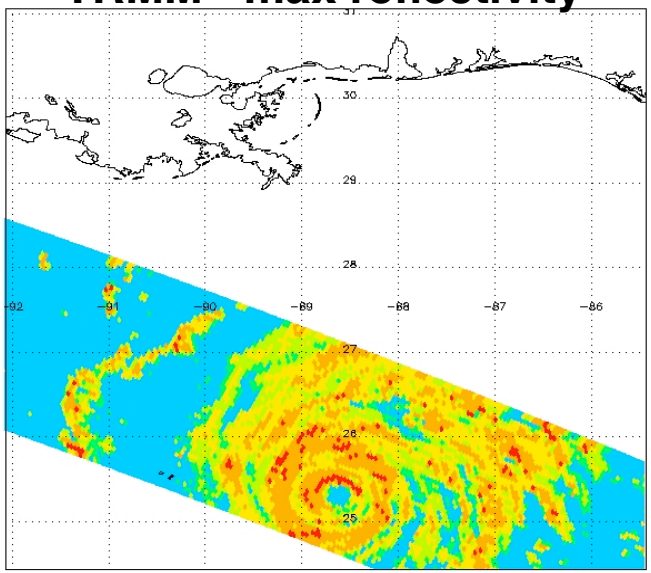
WRF - Path Attenuation



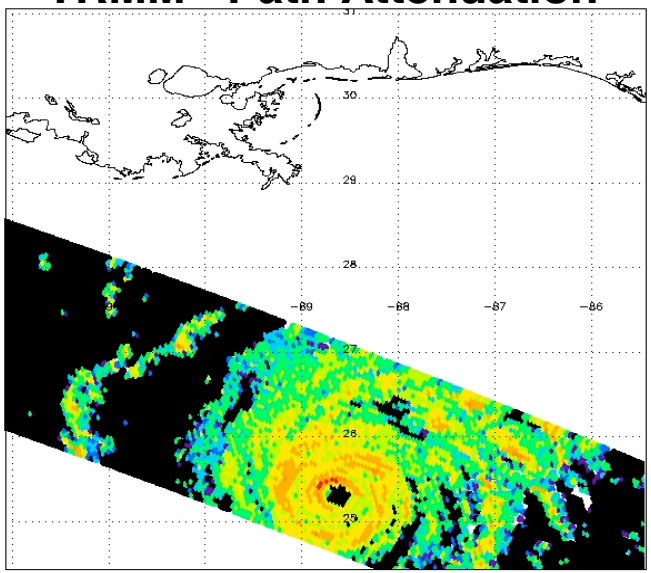
TRMM -Rain Rate



TRMM - max reflectivity



TRMM - Path Attenuation

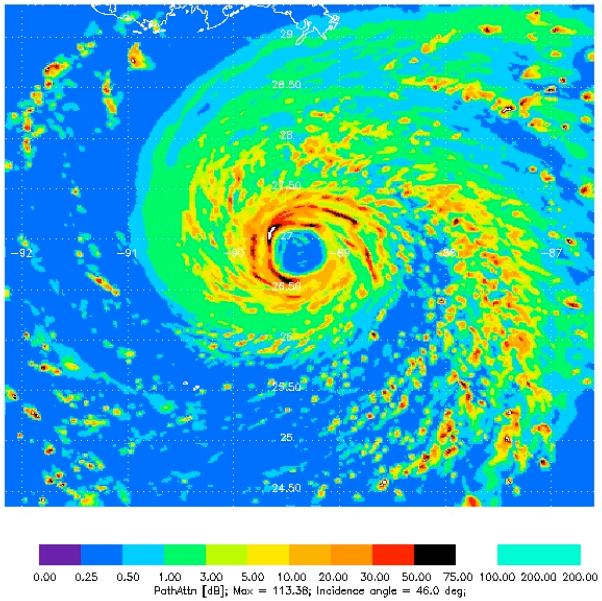


Hurricane Modelling and Instrument Simulators for Mission Design

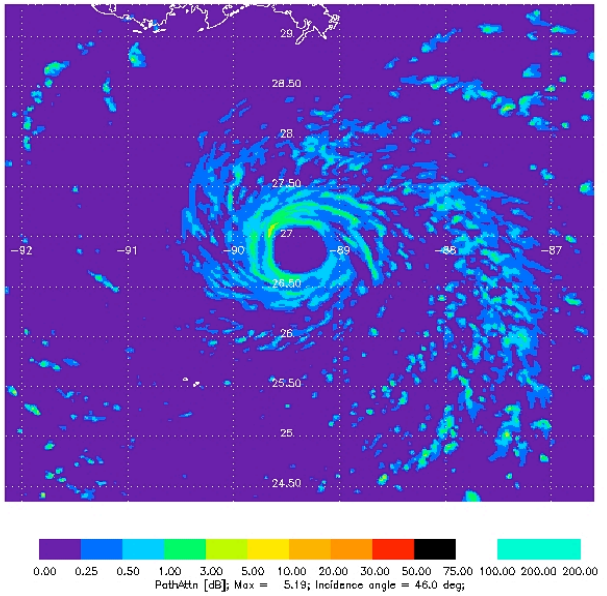
WRF output fields can be used as input to instrument simulators (e.g. Volume Backscatter, Path Integrated Attenuation, Wind-Induced Sigma0)

Example: enable the design of the future scatterometers by simulating rain-associated contributions to the wind sigma0 for Rita – 15:30Z, Sep. 22, 2005

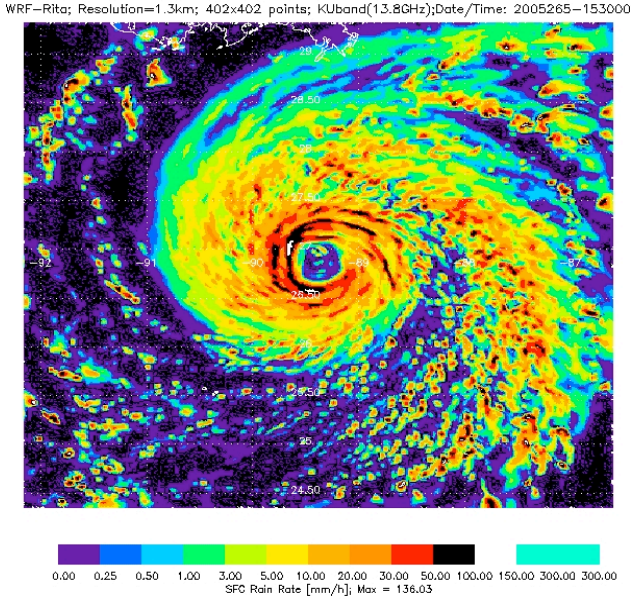
Ku band - Attenuation



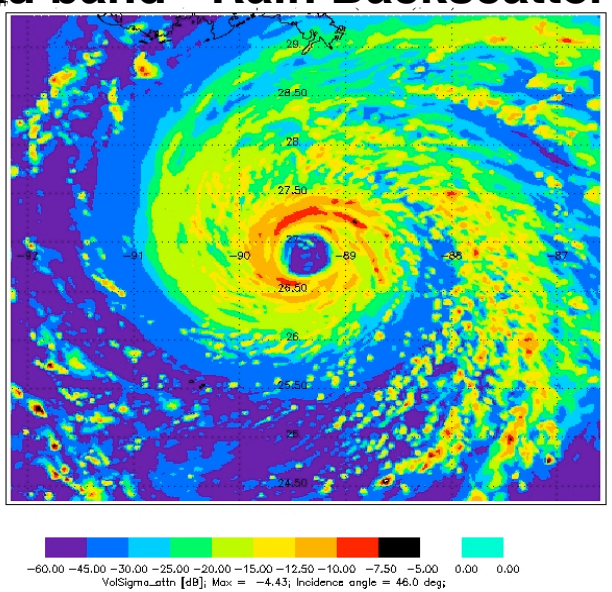
C band - Attenuation



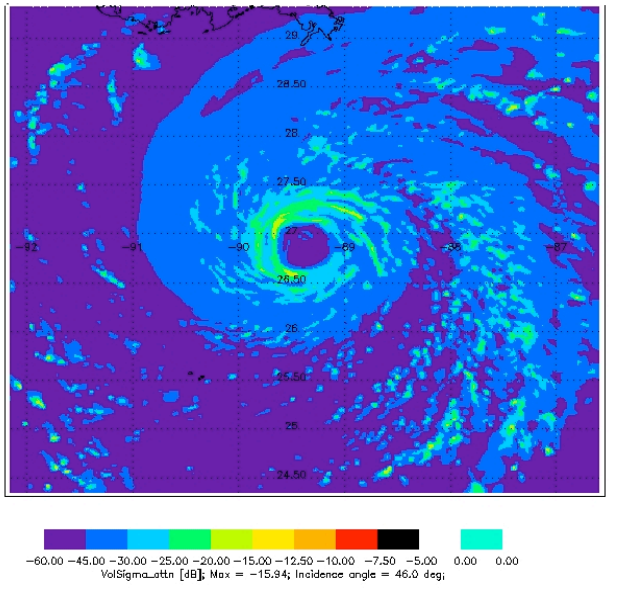
WRF Rain Rate



Ku band - Rain Backscatter



C band - Rain Backscatter



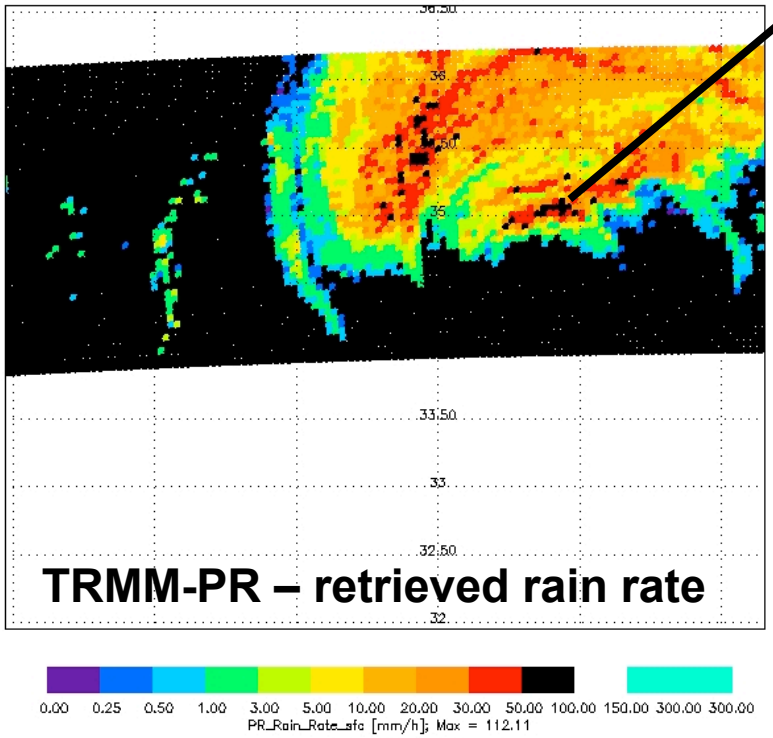
Evaluating hurricane simulations….

Impact of model microphysics

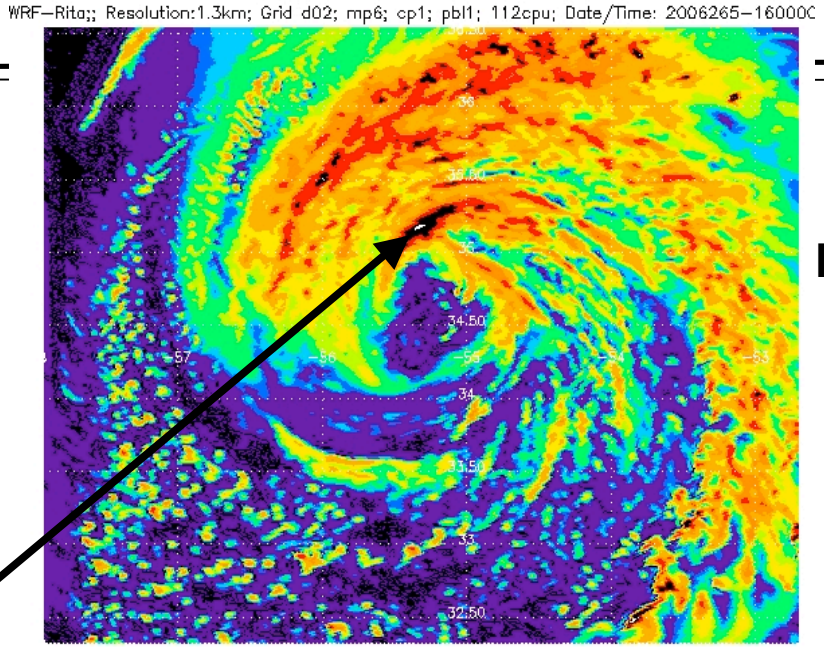
The treatment of microphysical processes in hurricane models has impact on the structure and the intensity of the forecasted storms.

The question is whether satellite observations provide enough information to help select the microphysical parameterization that produces the most realistic storms.

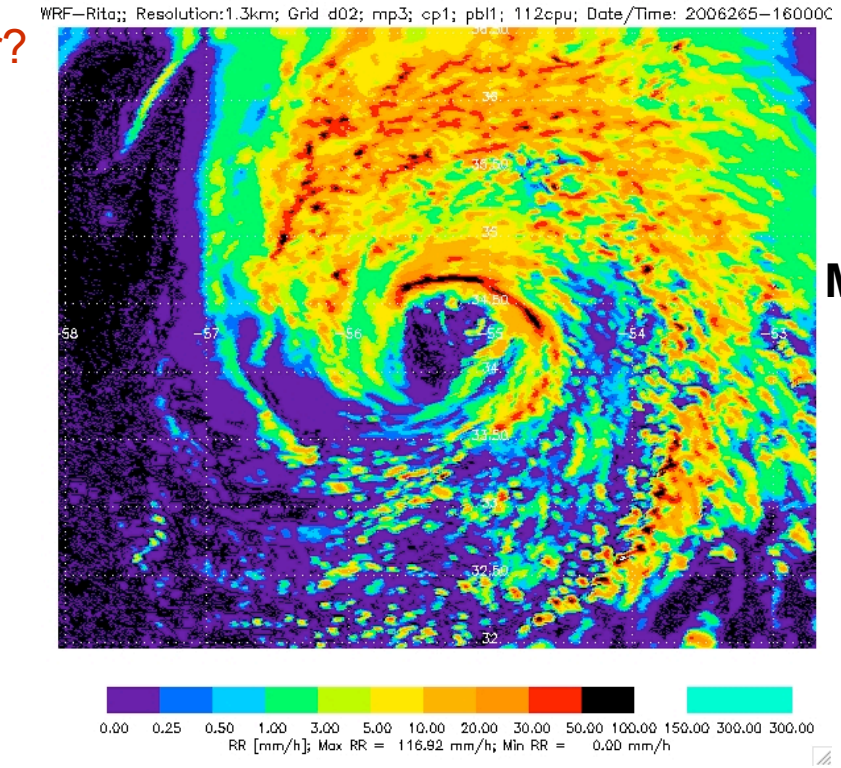
Preliminary research shows that, indeed, satellite observations can help discriminate between simulations with different microphysics and select the most appropriate one.



Better?



Micro6

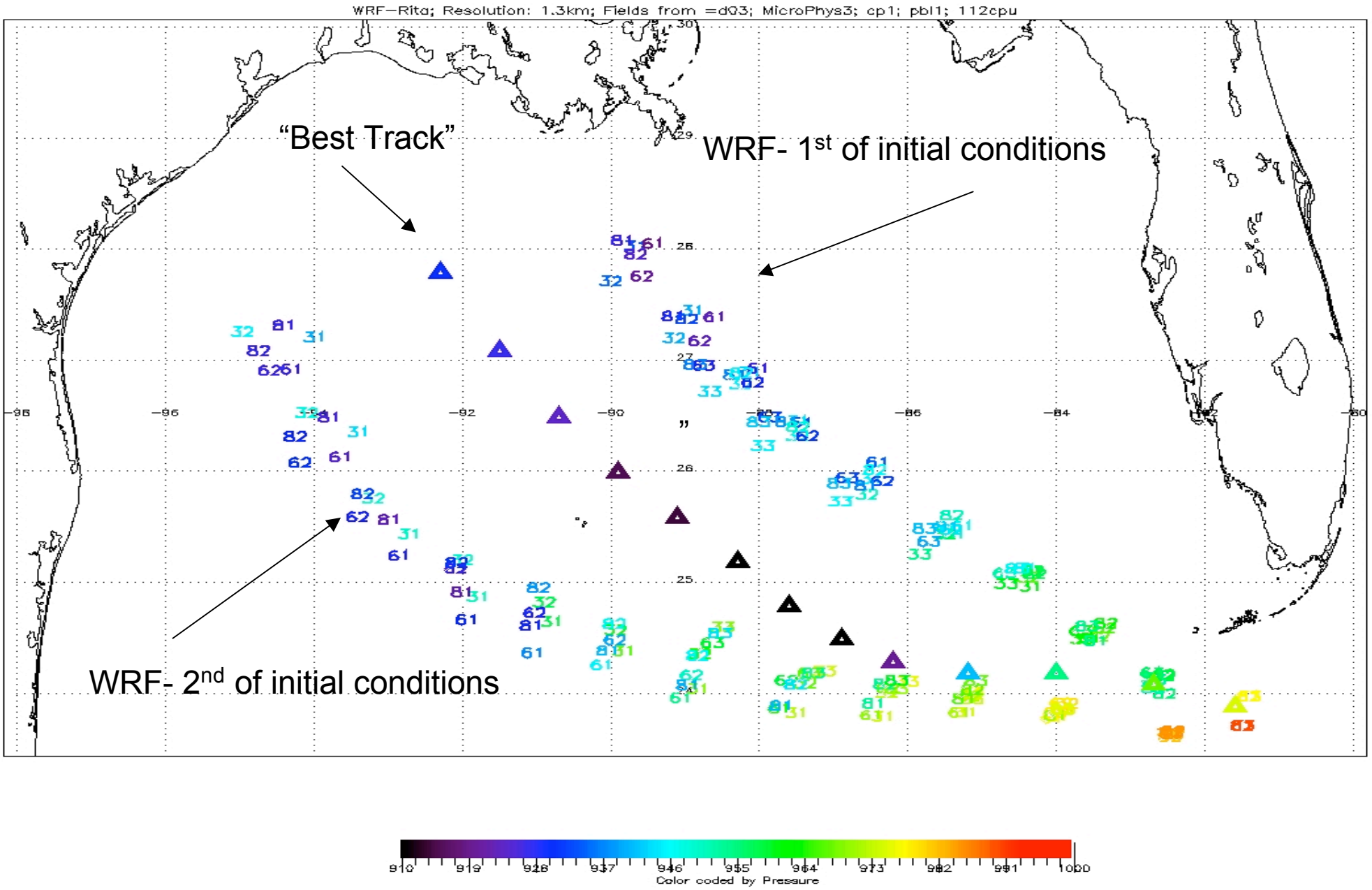


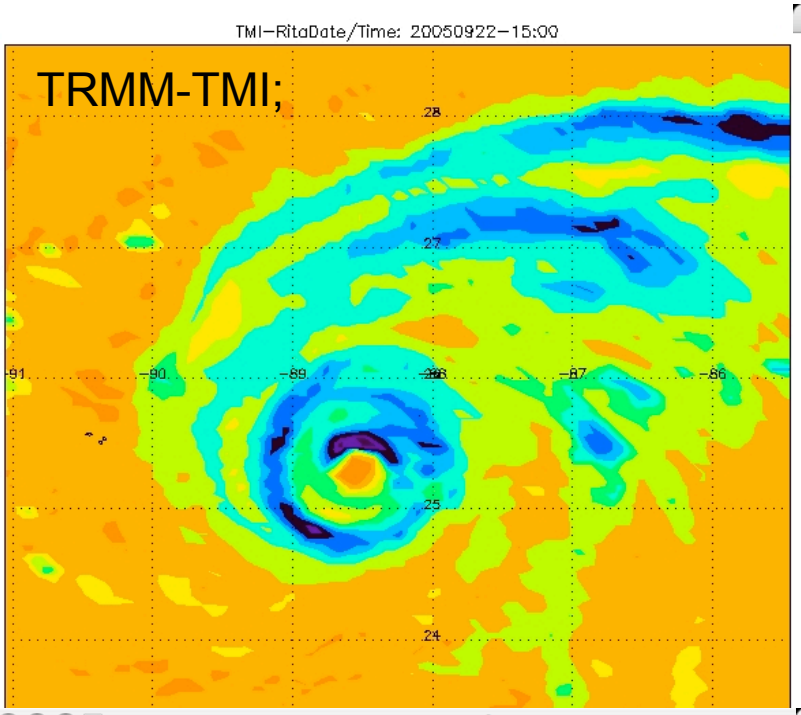
Micro3

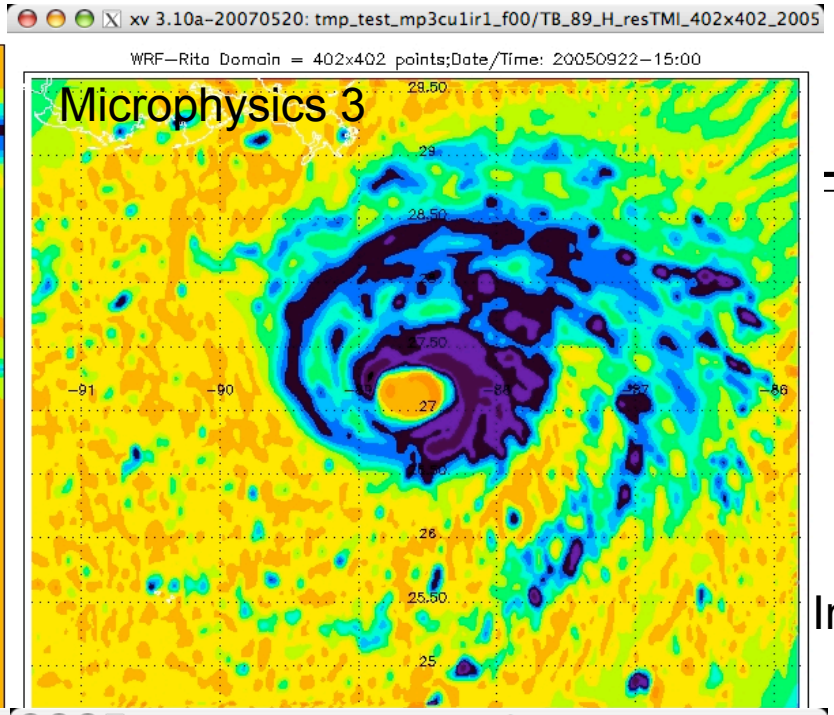
31 - microphysics 3; convective scheme 1
32 - microphysics 3; convective scheme 2
33 - microphysics 3; convective scheme 3

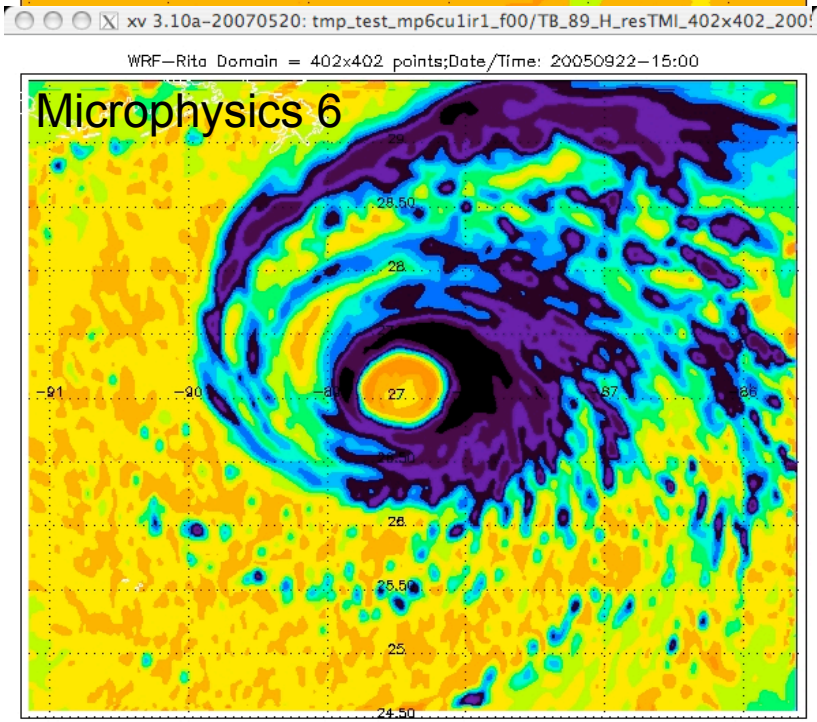
61 - micro. 6; conv. 1
62 - micro. 6; conv. 2
63 - micro. 6; conv. 3

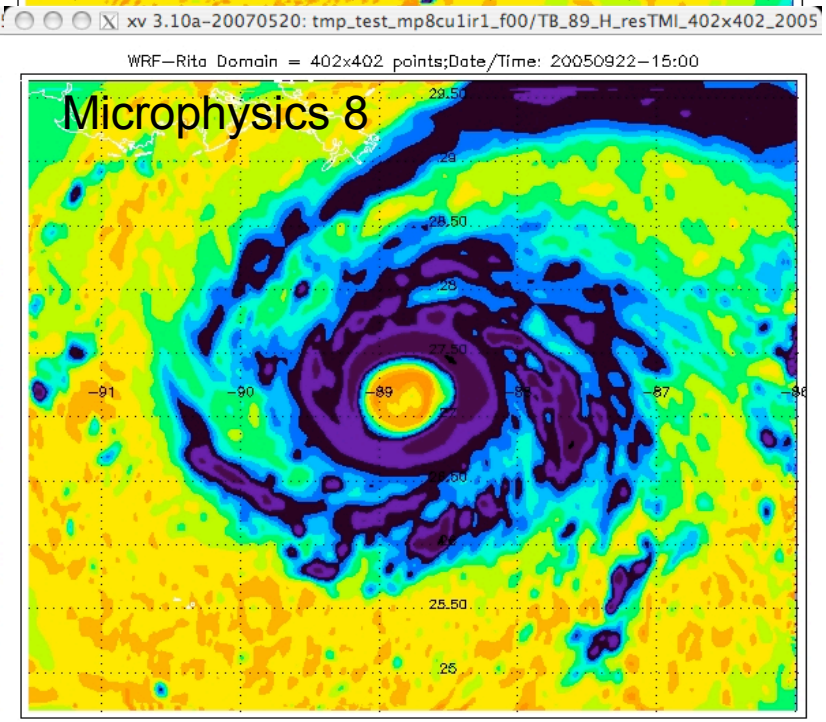
81 - micro. 8; conv. 1
82 - micro. 8; conv. 2
83 - micro. 8; conv. 3







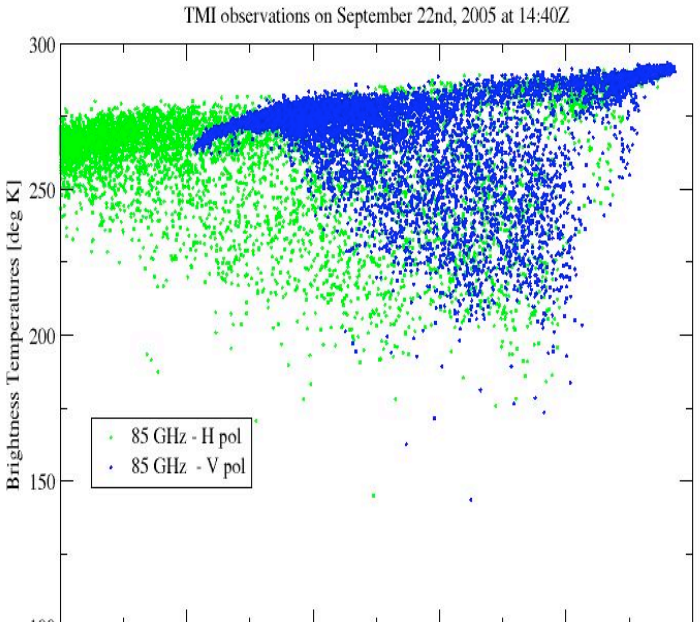


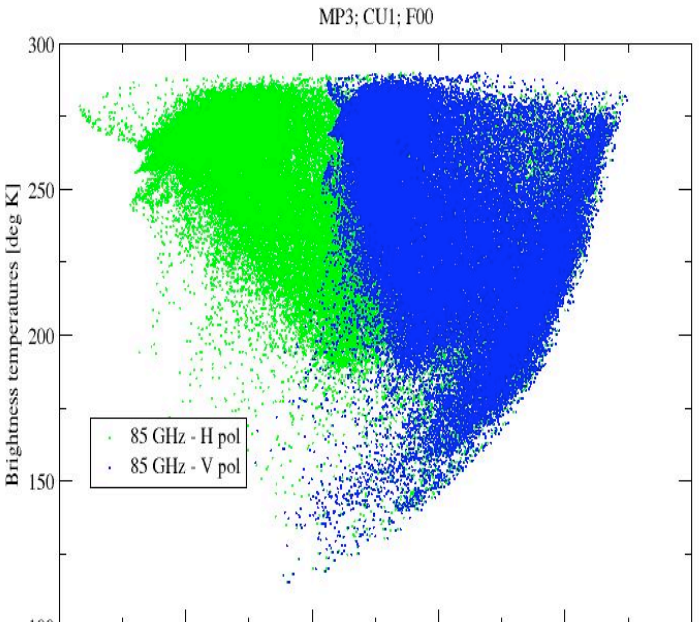


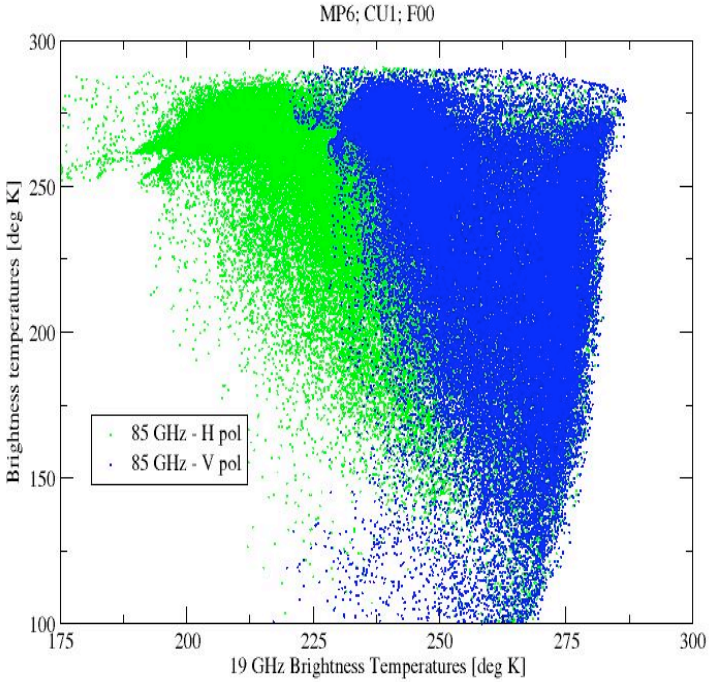
Example of
Using
Instrument simulators
and
Object Comparison
to investigate
the impact
of microphysics
on storm structure

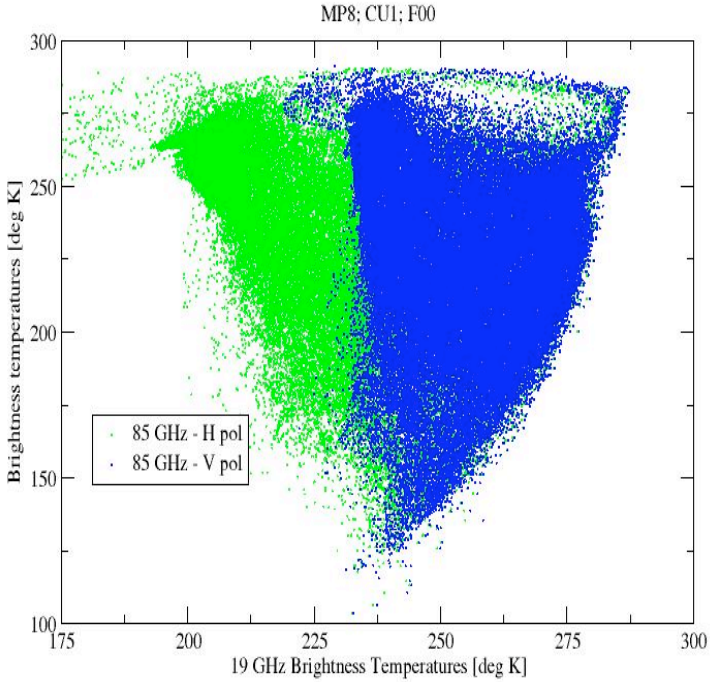
JPL

Backup









Example of channel relationships to evaluate the impact of microphysics on liquid/frozen partitioning in the vertical

Why Study Hurricanes ?

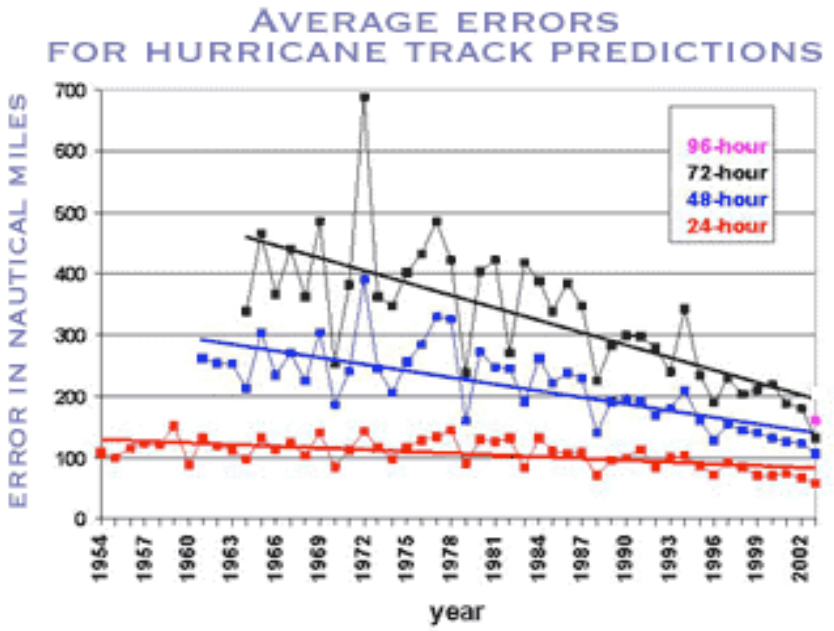
- Hurricanes are among the most destructive natural phenomena with huge societal and economic impact.
- Each year they threaten the US coast, cause damages worth billions and take life.
- Damages for 2008 only are estimated at $54 billion.
- Some 130,000 died when a cyclone struck Myanmar along the Andaman Sea in 2008.
- The deadliest U.S. hurricane was the 1900 Galveston storm, which killed 8,000 to12,000 people and destroyed the city. Katrina (2005) killed some 1,200 people, and left hundreds of thousands homeless.

Venice, Louisiana - 8/30/2005

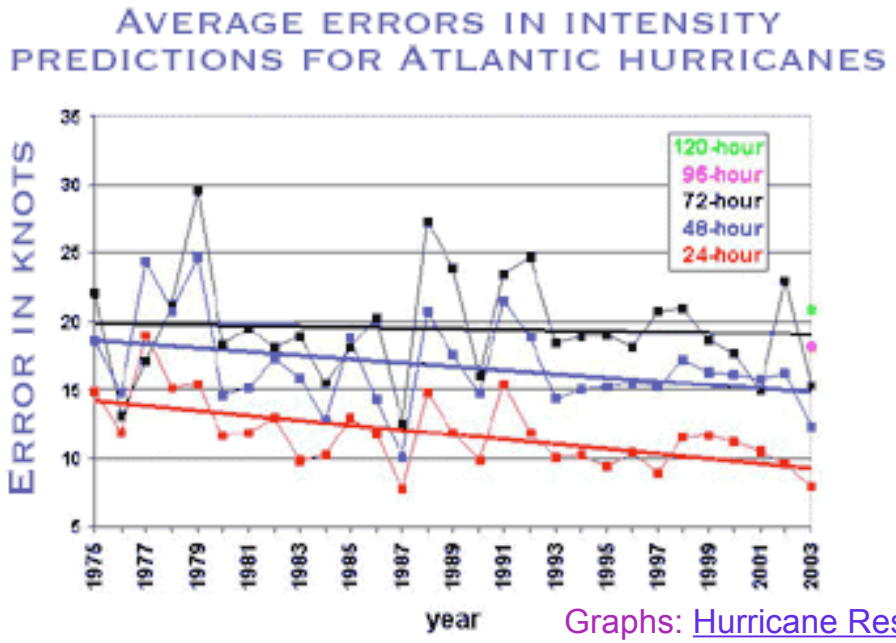
Galveston, Texas - 9/13/2008

Current state-of-the-art hurricane prediction

- **25% reduction in 48 hour track error over the past 6 years**



- **Intensity forecasts have not improved.**



Graphs: Hurricane Research Division

Unnecessary Costly Evacuations

- The approach of Rita provoked one the largest evacuations in U. S. history.
- The number of evacuees in Texas could have exceeded two million!
- direct fatalities - 7 ; “indirect” - at ~120 with the majority happening during the unnecessary evacuation.
- Disrupted oil and gas production

- NOAA established the Hurricane Forecasting Improvement Project in order to accelerate improvements in one to five day forecasts for hurricane track, intensity, storm surge and to reduce forecast uncertainty.

What needs to be done ...

- A need to understand the physical processes that determine hurricane track and evolution.
- A pressing need to validate and improve hurricane forecast models!!
- None of this can be accomplished without bringing together models and observations into a common analysis system which does not yet exist
- JPL is uniquely positioned to accomplish that because of our:
  - extensive experience with satellite observations and intimate knowledge about retrieved products, many developed at JPL
  - ability to bring observations and models together by developing instrument simulators that use the model output and generate satellite "observables" needed:
    - for model-data comparisons
    - for data assimilation
    - for instrument and mission design

Objectives of the TCIS

To provide fusion of multiparameter observations (satellite, airborne and in-situ) **and model output,** relevant to both the large-scale and the storm-scale hurricane processes in the atmosphere and in the ocean **with the purpose of:**

- understanding the physical processes that determine hurricane genesis, intensity, track and impact on large-scale environment

- improving the hurricane forecast by facilitating hurricane model validation and improvement

- enabling studies aimed at developing new algorithms, sensor systems and missions.

How it all started ...

- Awareness phase: - Sept. 06-Dec. 06
  - Multiple JPL satellite missions measure various aspects of hurricanes
  - Several NRC decadal survey recommended mission concepts are related to hurricanes
  - Three groups run hurricane models
- Formulation phase - Jan. 07
  - A virtual group has been established with bi-weekly meetings
  - Hurricane Lecture Series
- Design phase
  - May 07: ISC R&TD proposal submitted and funded
  - Sept. 07: Successfully delivered the database/web-portal prototype and submitted the ISC R&TD final report and poster
- Development phase
  - Dec. 08: Released the portal for public use with one full year of globally observed tropical cyclones.

What we have have achieved

- **Members of the group submitted a number of PI-lead proposals (7) and participated as Co-Is in a significant number of other proposals**
- **Two of the PI-lead proposals have been funded and a third one is a serious contender. One of the Co-I proposals has also been funded.**
- **There are a couple of proposals still pending**
- **Established collaborations with:**
  - **Researchers from NOAA's Hurricane Research Division and the National Hurricane Center**
  - **Researchers from the Naval Postgraduate School**
  - **Researchers from the Academia**

Where do we go from here?

- Specific Objectives
  - Enlarge the Hurricane database to create Decadal time series to address the question: Can global warming increase the hurricane frequency and/or intensity?
  - Analysis tools to enable multi-sensor data/model fusion
  - Add hurricane model output to enable model evaluation
  - Support future field campaign and satellite mission design
- Expand collaborations
  - Organize a workshop to promote the TCIS and to seek active input from the scientist on the future development
- Look for funding opportunities
- Establish new collaborations - we are looking for your input!!